

## ABSTRACT

A method is provide for using abrasive colloidal particles having multi-component composition comprising mixed 1) metal or metalloid oxides, 2) oxyfluorides, or 3) oxynitrides, each grouping (1, 2, or 3) individually alone or in combination thereof, in a chemical-mechanical manufacturing process for planarizing or polishing metal, semiconductor, dielectric, glass, polymer, optical, and ceramic materials. The particles exhibit a modified surface chemistry performance and have an isoelectric point ( $\text{pH}_{\text{IEP}}$ ) greater than the pH of the dispersed particles in solution, and with a stabilized particle dispersion at pH values of interest for CMP operations. The composition of the multi-component particles may be adjusted as desired, in regard to their chemical or physical properties such as surface chemistry, hardness, solubility, or degree of compatibility with the workpiece material being planarized or polished. Also provided is a chemical-mechanical planarization slurry mixture incorporating such multi-component particles and with a solution chemistry that enhances the CMP effects by in-part adjusting the pH of the solution away from the  $\text{pH}_{\text{IEP}}$  of the media to maximize dispersion.